Assessment of land use land cover changes and its impact on groundwater resources of Kamrup along the banks of the River Brahmaputra

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Introduction

Background

- Groundwater: ensures global food security
- Changes in land use land cover (LULC) continuous process at local, regional as well as global level
- The unprecedented expand in the expanse under urban environment due to increasing population and economic development.
- Subsequent increase in the stress on hydrological cycles and sustainability

Motivation

High water potential, yet growing scarcity in the region.
Necessitates:

1. Quantitative analysis of groundwater levels
2. Correlation assessment between anthropogenic activities (LULC) and groundwater level (GWL)

Study Area

1. Between 25°46' to 26°49' N latitudes and 90°48' to 91°50' E longitudes in the banks of River Brahmpautra

2. Area of 4,340 sq. km

3.Soil texture constitutes of the **sandy, silty, clayey loam**

4. Temperature range: 7.0 to 39.5°C

5. Average precipitation: **2200 mm/year**

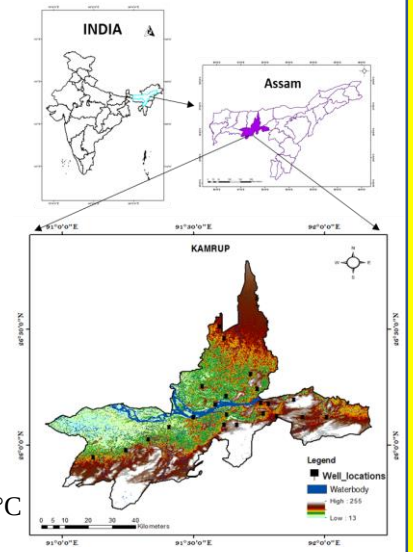

Fig.1 Study area

Objectives

Aim: To determine the effect of human interferences on the declining groundwater levels of the alluvium in the Kamrup district

1. Changes in the land use land cover over the past decades for the Kamrup district 2.
2. Trend analysis of the groundwater levels (1990-2020)
3. Effect of LULC on the groundwater levels
4. Correlation between urbanization and groundwater levels (GWL)

Data and methodology

ManKendall Trend analysis

$$Z = \begin{cases} \frac{S-1}{\sqrt{var(S)}}, if\ S > 0 \\ 0, if\ S = 0 \\ \frac{S+1}{\sqrt{var(S)}}, if\ S < 0 \end{cases} \qquad S = \sum_{i=1}^{n=1} \sum_{j=i+1}^{n} sig(X_j - X_i)$$

$$sig(X_j - X_i) = \begin{cases} +1\ if\ (X_j - X_i) > 0 \\ 0\ if\ (X_j - X_i) = 0 \\ -1\ if\ (X_j - X_i) < 0 \end{cases}$$

where n the is length of the dataset, *Xj* and *Xi* are the time series data in chronological order in years' values *j* and *i*, *j* >*i*, respectively

Data sources: LULC: Sentinel, Landsat, **GWL**: CGWB well data

Spatio-temporal LULC mapping

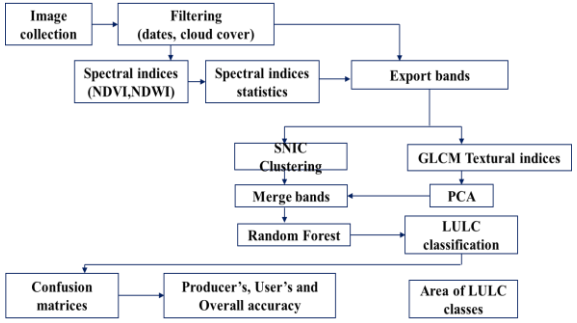

Fig.2 GEE workflow for LULC analysis

Results

LULC analysis

1. Accuracy: satisfactory (>80%)
2. 58.9% decline in agriculture
3. Groundwater level decline follow the urban cover increase

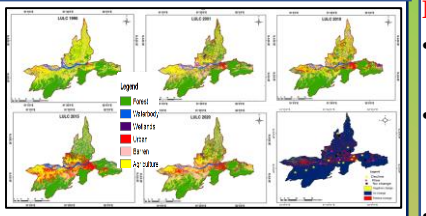

Fig.2 LULC of 1990, 2001, 2010, 2015, 2020, well locations in ID map (1990-2020)

Man-Kendall trend analysis

1.Pre-monsoon: 42% falling 19% rising, Monsoon: 3 wells show rising

2. 39% of the well locations show statistically significance falling trend

3. Maximum decline :0.13 m/yr, minimum decline rate of 0.03 m/yr

4. Average rise 0.16 m/yr: 16%

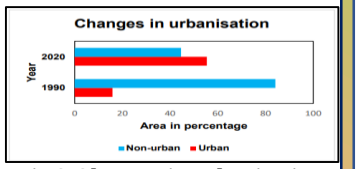

Fig.2 Changes in urbanisation (1990-2020)

Pervious cover: 40% decline

Impervious: 39.54% increase

Image differencing (ID) analysis

Change in urbanisation detection

1. Impervious to pervious: **no change value (0)**
2. Pervious to impervious: **positive change: value (1)**

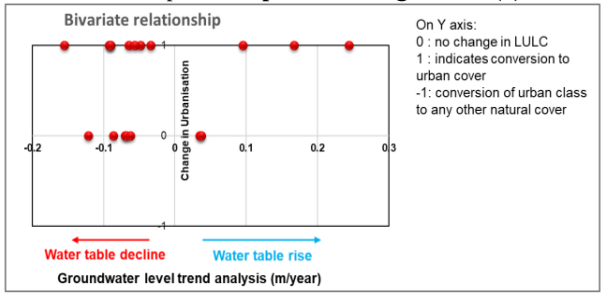

Fig.3 Correlation between GWL and urbanisation (1990-2020)

Observations from correlation analysis

- 52% in positive change and decline in GWL
- Rise in GWL wells in no change

Conclusions

Inferences

- Object based image classification in GEE: effective for LULC analysis
- Man-Kendall trend analysis of the groundwater level observation data: 35% wells with declining trend, 14.13% with rising trend.
- 60% of the well locations with significant declining trend in water level lie in the positive change region

Summary

1. Out of the 23 considered wells: 56% wells show a significant trend at 95% confidence interval
2. Rapid transformations in terms of urbanization over three decades
3. The consistency between the wells with a significant declining trend and urbanization indicates probable effect of LULC on the GWL

References

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